Operating and Maintenance Manual
NEUFORM CR3-V (R2 Series)
-In-Flight-Adjustable Pitch Propeller-

Related Types:

CR3-V-70-(IP)-R2-H
CR3-V-80-(IP)-R2-H

(hydraulic manual control)

CR3-V-70-(IP)-R2-ECS-M
CR3-V-80-(IP)-R2-ECS-M
CR3-V-70-(IP)-R2-ECS-M-iS
CR3-V-80-(IP)-R2-ECS-M-iS

(electric constant speed control)

Rev1./ 05 March 2018

Manual according to ASTM-F2506-13, Part.-No. 10440

WARNING:
Prior to mounting and prior to the first use of the NEUFORM CR3-V-R2 Propeller the manual must be read completely and carefully as it contains safety relevant information!

The manual must remain with the propeller in case of sale.

0. RECORD OF REVISONS

Revision	Date	Subject
First Edition	25.11.13	Based on *Operating Manual R2-Series-20120405*, fully revised in order to ensure compliance to ASTM-F2506-13
Revision 1	5.06.18	Redefinition of 750-Hours Check to *Factory Overhaul* and increase of interval to 1500 operating hours or 8 years.

1. General

The NEUFORM Variable Pitch Propellers are designed for the operation in microlight (ultralight), light sport aircraft (except USA) and experimental aircraft basically in connection with Rotax aircraft engines. They can be adjusted in flight. That means that you can change the blade angle during operation and thus adjust the propeller perfectly to the operating conditions of your aircraft. The result is better performance at takeoff and more economical cruising.

You can choose between manual control of the propeller by a hand lever in the cockpit or an automatic constant speed control. Just choose the desired engine rpm, everything else will run automatically. The propeller will be set by the controller for an optimized performance and you are free to enjoy flying.

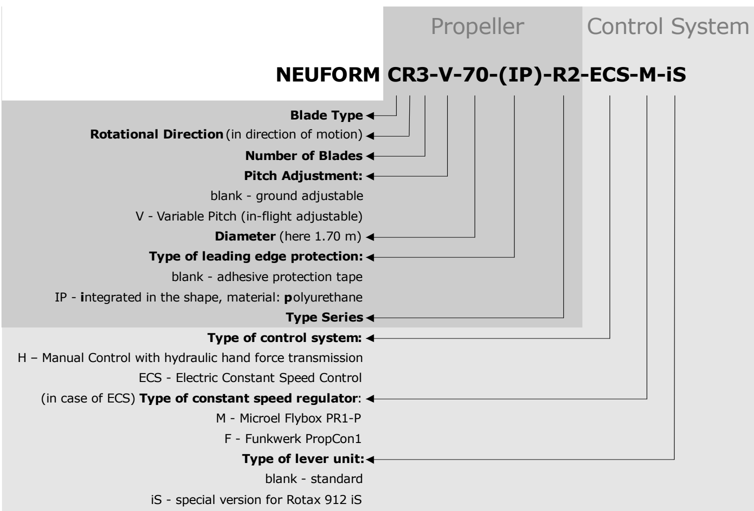
The propeller is low in maintenance and runs smoothly.

For safe operation, operation limits and due maintenance intervals must be observed.

1.1. Modular Conception of CR3-V-R2 Series

Propeller System	Part No.	**Consisting of**			
		Propeller	Part No.	Control System	Part No.
CR3-V-70-(IP)-R2-H	*0500	CR3-V-70-(IP)-R2	*0100	H	*0119
CR3-V-80-(IP)-R2-H	*0501	CR3-V-80-(IP)-R2	*0101	H	*0119
CR3-V-70-(IP)-R2-ECS-M	*0502	CR3-V-70-(IP)-R2	*0100	ECS-M	*0159
CR3-V-80-(IP)-R2-ECS-M	*0503	CR3-V-80-(IP)-R2	*0101	ECS-M	*0159
CR3-V-70-(IP)-R2-ECS-M-iS	*0504	CR3-V-70-(IP)-R2	*0100	ECS-M-iS	*0215
CR3-V-80-(IP)-R2-ECS-M-iS	*0505	CR3-V-80-(IP)-R2	*0101	ECS-M-iS	*0215

1.2. Type Description



Note:

Wherever in the context of this manual precise distinction is not necessary the propellers will be simply referred to as CR3-V-R2.

1.3. Certifications

For the CR3-V-R2 propellers referred to in this manual compliance to ASTM-F2506-13 has been shown. Beyond that, the propeller has no certification according to FAR-, EASA- or comparable rules.

1.4. Construction and Functional Features

The NEUFORM CR3-V-R2 propeller basically consists of a two-parts aluminium hub and three composite propeller blades. The propeller is controlled by an actuator unit (named *lever unit*) located on top of the gearbox. Connected to a push rod inside the hollow gear box shaft and by means of a lever, it transfers movement and control forces to the centre of the hub. There an especially shaped metal piece forwards and synchronizes the movement onto the blades, each of which therefore featuring an excentric bolt.

The propeller blades consist of an upper and a lower shell made of glass fibre and carbon fibre reinforced plastic and a core made of a special high-resistance foam. The glass fibre shell of the propeller blade is meant to take on the forces that occur during operation. Therefore special attention needs to be paid to the shell during the daily checks. The leading edge of each blade is covered by a leading edge protection made of abrasion resistant special polyurethane, which is integrated in the shape. If it's worn it can be replaced by NEUFORM.

There are two possible control systems. The *manual control system* is actuated by a hand lever in the cockpit (Control H), which transfers the hand force by hydraulic pressure to an actuator cylinder on top of the lever unit. The appropriate pitch has to be chosen by the pilot. In case of *electric constant* speed *control* (Control ECS-M) there is an electric spindle drive on top of the lever unit instead, which is controlled by an electronic controller device in the cockpit. Once the desired rpm is has been chosen by the pilot, everything else is acting automatically.

1.5. Acceptable Engines

The operation of NEUFORM CR3-V-R2 is acceptable with the following engines:

Manufacturer	Type	Nominal Performance	Reduction Ratio
Rotax	912 UL / A / F config. 2 or 4	59.6 kW	2.273
Rotax	912 UL / A / F config. 2 or 4	59.6 kW	2.43
Rotax	912 ULS / S config. 2 or 4	73.5 kW	2.43
Rotax	912 iSc / iS config. 2	73.5 kW	2.43

Operation with similar engines is conceivable, if it is ensured, that the propeller is always operated within its operating limits. If mounting of an engine not mentioned in the list is desired please contact Neuform by all means.

Remark: Originally the propeller has been designed for operation with Rotax 914 as well. In order to keep compliant to ASTM-F2506-13 the Rotax 914 has been removed from the original list, since the verification of compliance to the standard has been shown only with regard to the engines in the list above so far.

1.6. Technical Data

Propeller Type	**CR3-V-70-(IP)-R2**	**CR3-V-80-(IP)-R2**
Diameter	1,70 m/67"	1,80 m/70.9"
Mass moment of inertia*	4600 kg/cm^2/ 4.07 lb·inch·s^2	5100 kg/cm^2/ 4.51 lb·inch·s^2
Weight*	9,8 kg/21.6 lb	9,9 kg/21.8 lb

*) Since the propeller blades are handcrafted, slightly variations in total weight and mass moment of inertia are possible

Control System Type	**H**	**ECS-M**	**ECS-M-iS**
Weight*	1,1 kg/2.43 lb	1,4 kg/ 3.09 lb	1,5 kg/ 3.31 lb

2. Operating Limitations

Various loads have an effect on the propeller during the operation. The loads consist of bending loads due to thrust and the power applied, centrifugal forces and gyroscopic loads. They basically depend on the number of revolutions and on the power with which the propeller is operated:

2.1. Maximum Allowable Propeller Rotational Speed

Maximum allowable propeller speed: $n_{max} = 2600 \text{ min}^{-1}$

2.2. Maximum Allowable Engine Power

The maximum nominal allowable power input to the propeller is limited to 73.5 kW. (see Remark in *Acceptable Engines*, page 5)

2.3. Life Limitations

So far though no problems in connection with ageing or fatigue have become known, so the time of use is not restricted to a flat rate. However it is absolutely necessary to carry out the Factory Overhaul (see page 13) in order to guarantee a safe operation.

2.4. Aerobatics

Aerobatics cause higher loads to the propeller. This propeller has not been tested for aerobatics. That's why aerobatics are not allowed.

3. Flight Operation

3.1. Usual Operation

Prior to operation make sure that the daily check (see 5.2, page 12) has been carried out. Always choose a flight path that ensures a landing without engine any time.

WARNING! Never operate the propeller on ground while persons or animals are close.

The pilot is responsible for keeping the propeller within its operation limitations any time.

3.1.1. Manual Control Operation ("Control H"):

3.1.1.1. General Remarks

Control is done in several steps via the hand lever in the cockpit. The foremost pitch means "take off with maximum engine speed", the hindmost pitch "cruising". Right beneath the hand lever is the release (unlocking device). The lever snaps in at the respective pitch and thus assures a stable setting angle in the chosen position. Released (unlocked), the lever moves back through aerodynamic forces or return spring forward to the "take off" position. Against this reset force, any pitch can be chosen now by easy manipulation.

Note: Generally, the propeller ought to be adjusted by checking the rev counter ONLY and not by the setting of the lever.

3.1.1.2. Start-Up of the Engine and Pre-Flight Check

At start-up of the engine, the propeller lever must be set to the foremost pitch.

As soon as the engine is warmed-up, a brief propeller-check must be performed. For that, the engine has to be run at a speed of 4000 1/min with the help of the throttle lever while the propeller lever is in take off position. Then pull the lever into cruising position. This must cause a significant slowing-down of the engine speed by several hundred revolutions per minute. The precise revolution speed is irrelevant. Then, the propeller level will be brought back into take off position. Here, the revolution speed will have to correspond exactly with the previous revolution speed. Should no significant lowering of the revolution speed be reached or should the revolution speed at the end of the check not correspond with the previous revolution speed, operational deterioration of the propeller must be assumed. The aircraft must not take off and the propeller will have to undergo a technical check.

After successful functionality check, the propeller can be brought to the intended take off position. The propeller should only be set to the foremost pitch/position if full take-off performance is needed, for example at very short runways or for aeroplane towing. In most cases, more moderate setting is advisable.

CAUTION: To not exceed the maximum revolution speed of the engine, we recommend not to set pre-flight a higher revolution speed than 5500 1/min.

3.1.1.3. Take Off

The propeller revolution speed changes very little during take off, so no adjustment of the propeller is necessary until after take off and the following climb flight a speed of 100 km/h is reached because the engine will not build up too high a revolution speed. Thus, the pilot's full focus can remain on the take-off. Still, the revolution counter ought to be watched carefully. For further increase in speed the propeller setting angle will have to be adjusted by pulling the propeller lever. The best climbing performance is reached at approx. 110-140 km/h, depending on the type of aeroplane.

3.1.1.4. Cruising

During cruising, one of the performance settings recommended by the engine manufacturers (see engine manual) can be engaged.

3.1.1.5. Landing

Put the propeller in "take off" position for approach. Please include the item "propeller in take-off position" (lever turned forward as far as it will go) with the landing check.

3.1.1.6. What happens in Case of Control System Failure? (H)

In the case of a failure of the control system, the propeller turns back into "take off" position. Should that happen during fast cruising, this may result in very high engine speed. Reduce throttle to avoid excessive engine speed! Reduce airspeed!

Note: The narrowest possible setting angle is mechanically limited within the hub. It is technically impossible to narrow this limited angle any further. This means that even in a worst case scenario the propeller will still perform at maximum climbing performance. Zero-, let alone reverse thrust, will not occur.

3.1.2. Constant Speed Control Operation ("Control ECS-M")

3.1.2.1. General Remarks

Operation is performed through the propeller control unit "Flybox PR1-P" in the cockpit. The propeller control unit controls the electric spindle drive for infinite adjustment of the propeller blade angle.

Propeller control unit Flybox PR1-P

The control unit knows two working conditions:

During **MANUAL**-mode the servo motor can be reached directly through the RPM-INC/DEC-switch. As the propeller is operated manually in this condition, chapter a) applies. Operation can be performed similar to the manual control version. However, the MANUAL-mode should only be used in case of malfunction or ambiguity. Standard operation is performed in **Constant Speed**-mode.

During **Constant Speed**-mode, constant speed control is operational. The pitch of the propeller is automatically set to the engine speed the pilot requires. This is done by comparing the required speed (below in the display) with the actual speed (above in the display).

Therefore, the main function of the propeller control unit is to keep the engine speed required by the pilot as steady as possible.

The required engine speed is put in via the RPM-INC/DEC-switch or by the knob in the middle of the control unit.

In order to avoid over-revving, it is recommended not to choose any set points exceeding 5500 1/min.

Background: Although the controller is working very quickly, depending on the active pitch of the propeller, it may take a few seconds until the propeller reaches the target pitch commanded by the controller.

It is recommended to pull the throttle lever only with great caution during flight (ca. 3 sec for the transition from idle speed to full throttle).

Background: If idle speed is chosen during flight, the control unit will detect a downward deviation from the engine speed and will react to such a situation by lowering the setting angle to the stop position, which is the minimum angle setting for the propeller meant for very slow speed only. At sudden accelerating, (e.g. touch-and-go), the setting drive will need about 3 seconds to reach a point that corresponds with the actual flight speed. The result is an over-revving during those 3 seconds.

This effect is, of course, the smaller the slower the aircraft flies. At a standard approach for landing, the danger of an over-rev is only minimal. For an aircraft on ground, the effect is non-existent.

If the pilot forms a habit of accelerating always very carefully, the effect can be avoided at all speeds.

3.1.2.2. Start-Up of the Engine and Pre-Flight Check

The propeller control unit is switched on only after start-up of the engine. As soon as the AUTO-mode is activated, the display will show a pre-set engine speed.

As soon as the engine is warmed-up, a brief propeller-check must be performed. For that, the engine has to be run at a speed of 4000 1/min with the help of the throttle lever.

With the RPM-INC/DEC-switch the set point will be lowered by some hundred rpm; the actual value will have to follow and to be lowered accordingly. In order to end the test the controller will be simply set back to Constant Speed Mode. The propeller than has to turn back to the original 4000 1/min. If the actual value doesn't follow as required, operational deterioration must be assumed. The aircraft must not take off and the propeller will have to undergo a technical check.

After successful pre-flight check, the required engine speed is set at the propeller control unit. **As explained above, please refrain from setting an engine speed higher as 5500 1/min**. For any normal case, an engine speed setting of 5024 1/min is absolutely sufficient. For the towing of banners and gliders or for taking off at extremely short runways, an engine speed of 5500 1/min will be ideal.

3.1.2.3. Take Off

Full throttle and up you go. With increasing speed the Propeller will be setting the appropriate angle without any help from the pilot.

3.1.2.4. Cruising

During cruising, one of the performance settings recommended by the engine manufacturers (see engine manual) can be engaged. For that, the appropriate engine speed will be chosen via the SET-key and with the throttle lever the required manifold pressure can be set.

3.1.2.5. Landing

Put the propeller in "take off" position for approach. Please include the item "propeller in take-off position" (set point ≥ 5024 1/min) into the landing check.

3.1.2.6. Go–around/Touch-and-Go

Pull throttle lever carefully. (See information on page 9.)

3.1.2.7. What happens in case of control system failure? (ECS-M)

In the case of control system failure, the pilot must switch to MANUAL-mode and check whether the propeller can thus be handled. If that is the case, set the "take off" position of the propeller manually (RPM-INC/DEC-switch).

If the propeller control unit fails to work entirely, the propeller will stay in its last position. That may lead to drastically reduced climbing performance. Chose your flight path accordingly! However, if the propeller was properly installed, there is, even at an extreme cruising setting, still a minimum climbing performance left, in accordance with the Airworthiness Requirements, in Germany for example according to LTF UL 2003: 1,5 m/s). Please take into consideration at landing that there is less performance available than usual for go-around/touch-and-go should it become necessary!

Should the mechanical connection between electric drive and propeller fail, the propeller will move to the setting of the smallest possible climbing position. Should that happen during fast cruising, this may result in very high engine speed. Reduce throttle to avoid excessive engine speed! Reduce airspeed to take off speed!

Note: The narrowest possible setting angle is mechanically limited within the hub. It is technically impossible to narrow this limited angle any further. This means that even in a worst case scenario of mechanical failure the propeller will still perform at full climbing performance. Zero-, let alone reverse thrust, will not occur.

3.2. Emergeny Operation

Depending on the control system used, please consult 3.1.1.6 or 3.1.2.7 for procedures in case of failure of the control system. However in general the following measures are essential:

Event	Possible reason	Actions
Sudden Engine Overspeed	- Break of control rod - Loss of pressure in hydraulic system (only manual control H)	**1. Reduce throttle immediately** (in order to keep engine rpm below max rpm) **2. Reduce airspeed to Take off airspeed** (see aircraft manual) **3. Land at the next possible airfield** Note: Due to a mechanic low-pitch limit inside the hub it is ensured that there will remain enough thrust to continue flight safely but slower and on an unusual high rpm level.
Unestimated Low Engine Rpm	- Failure of control system - propeller stuck in cruise pitch	**1. Keep throttle in a position that ensures level flight, full throttle if necessary.** **2. Fly preferably at cruising airspeed** **3. Land at the next possible airfield** **-> Attention: In case of missed approach and go around, keep in mind that there will be unfamiliar low (but sufficient) climb performance** Note: Due to a mechanic high-pitch limit inside the hub it is ensured that there will remain enough thrust to continue flight safely but on an unusual low rpm level.
Sudden Extreme Vibration	Loss of parts of blades (i.e. due to impact of foreign material, birdstrike)	**Cut off the engine and land in gliding flight immediately.**

4. Assembly and Adjustment

For assembly and disassembly please refer to the *Assembly- and Maintenance Manual R2-Series.*

> CAUTION: Any assembly of the propeller may only be performed according to "Assembly and Maintenance Manual V3-R2" not older than the issue dating 28 April 2010. The manual is exclusively meant for people with the necessary expertise. Although assembly is not very difficult to perform, we strongly recommend that it is only done by professional experts, not by laypersons.

5. Checks

5.1. After The First Flight

NOTE: After the first flight after each new assembly of the propeller hub, the tightening torque of the flange bolts must be checked as described in *Assembly- and Maintenance Manual R2-Series.* This is necessary to counteract torque settlement effects.

5.2. Daily Checks

Check the propeller prior to each operation for the following items:

- **Hub free of cracks**
- **Are all blades and all screws tight (visual check)?**
- **No damage of the propeller blade composite fabric**
- **No cracks in the blade surface**
- **No blade tip play (-> 8.3, page 15)**

5.3. 25 Hours after Propeller Assembly

25 hours after each new assembly of the propeller hub, the tightening torque of the flange bolts must be checked as described in 5.4.

5.4. 100-Hours Check

- Remove spinner cap
- Clean propeller thoroughly
- Perform daily checks (->5.2))
- Check the tightening torque of the flange bolts. Do not unscrew to do that. The correct tightening torque is 27 Nm. Use a calibrated torque wrench.

> **CAUTION: If the tightening torque is too high or too low, this may damage the screws!**

5.5. Factory Overhaul

After reaching the Time Between Overhaul (TBO) the propeller must be submitted to a Factory Overhaul at the NEUFORM works or at an authorized NEUFORM-Service-Partner. To keep a record of the operation time, a flight log must be kept. Any further operation of the propeller after reaching TBO is not permitted!

The Time Between Overhaul is defined as follows:

1500 hours of operation or 8 years depending on what occurs first.

6. Damages

The propeller must be taken out of operation if cracks in the blades or the hub or any other damage to the fabric occur. In all cases of doubt the operation has to be terminated as well.

Intensive wear of the integrated leading edge however is allowed and does not impair further operation as long as the fibre fabric beneath is not yet visible.

7. Repairs

Minor damage of the coloured surface may be repaired by persons with sufficient expertise. The necessary surface resin can be obtained through NEUFORM in small amounts.

All other repair of the blades should be made exclusively by NEUFORM. Any exchange of mechanical components can be performed at NEUFORM-Service-Points.

8. Servicing and Maintenance

8.1. Cleaning

Propeller and hub must be kept clean at all times to allow for a full sight check during the daily checks. For cleaning water with a bit of washing-up liquid and a soft sponge are recommended. From time to time the synthetic surfaces may be treated with car polish.

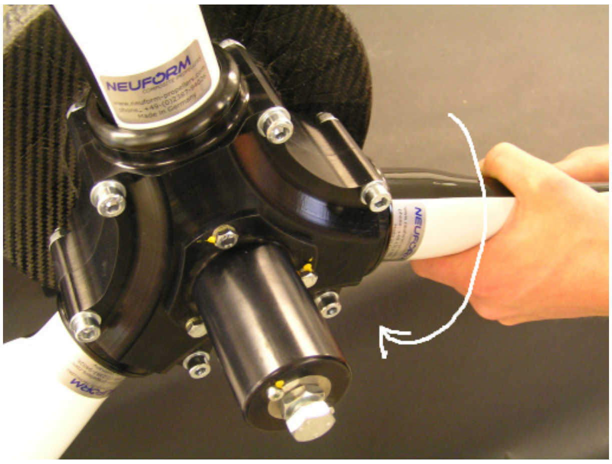
8.2. Lubrication

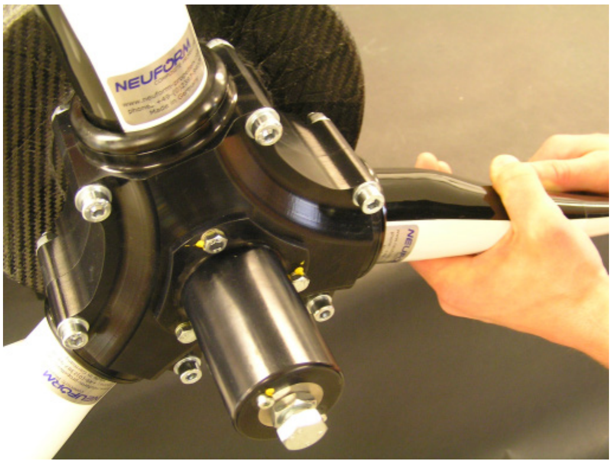
There is no set interval for refreshing the lubrication. It is performed if necessary.

Checking Lubrication

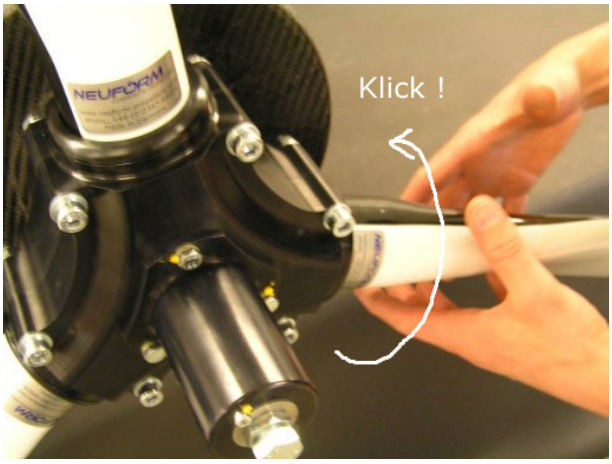
Check the state of the lubrication with a simple test. With the electric (ECS) drive the top connecting pin at the setting lever must be removed first, for manual setting (H) no preparation is required.

Hold one of the blades tightly by hand and turn it on its own axis towards a high pitch angle. (This will require some degree of strength, see the following pictures.)





At release, the blade and the propeller should flip back to the minimum pitch angle (take off position) and the stop should make a clearly audible "clicking" noise.



Should there be no "click" or should the propeller move only slowly back into its former position, then the lubrication is not adequate!

Please refresh the lubrication as shown in the Assembling- and Maintenance Manual. Anybody without expertise in this field should have this done by a professional person or company.

8.3. Blade Tip Play

Blade tip play itself is not dangerous but it lowers the service life of the bearings and thus ought to be put right immediately.

Checking for Blade Tip Play

Hold two of the blades tight with the hands and try to move them towards or away from each other. A discernible, evenly soft deformation caused by the elasticity of the blades is normal. Any uneven deformation is an indication of blade tip play.

In the case of blade tip play, contact your NEUFORM service partner.

CAUTION: Any manipulation of the bearing settings must under all conditions only be performed by authorised NEUFORM-Service-Staff.